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# *Debuncher Stochastic Cooling*

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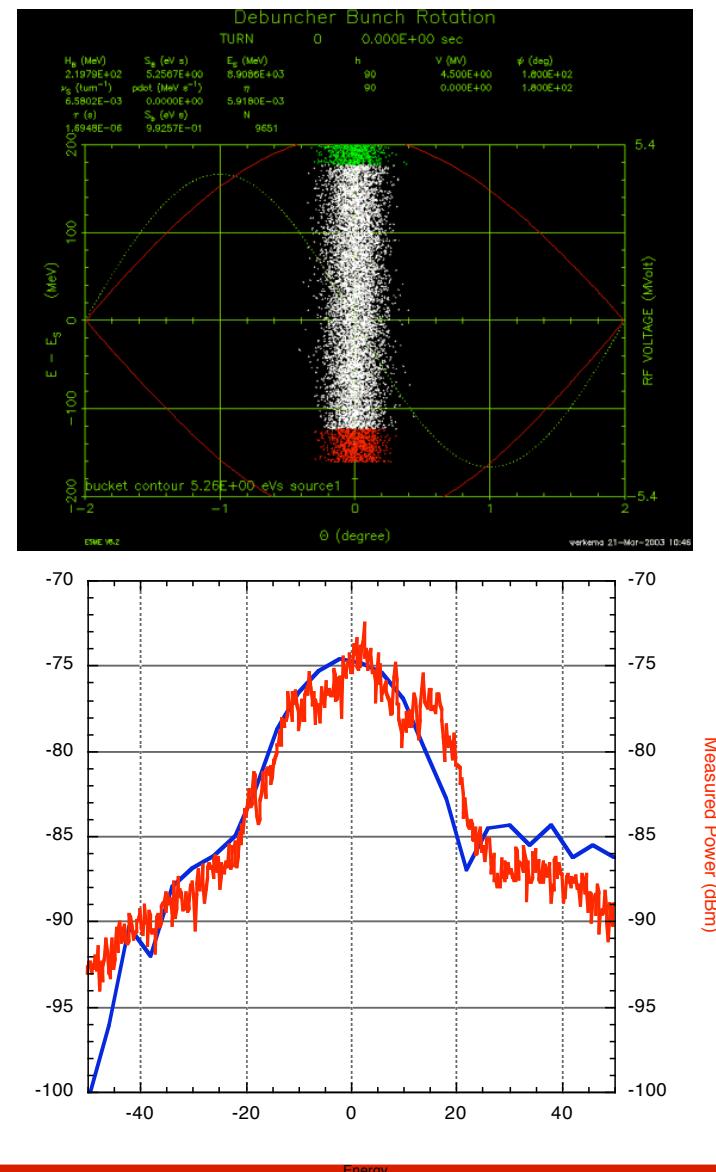
# Debuncher sequence

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- Bunch rotation: ~200 msec
  - Exchange
    - large momentum spread (~4%)
    - short time spread (~2 nsec)
  - For
    - Small momentum spread (0.4% or 36 MeV)
    - DC beam
- Stochastic cooling
  - Momentum and transverse
  - Liquid He front end ( $T_{\text{eff}} = 30 \text{ K}$ )
  - 4-8 GHz in 4 bands
  - 2400 W/plane (transverse), 4800 W (longitudinal)
  - Cooling Specifications:
    - Momentum: 36 MeV to 6 MeV in 1.9 seconds
    - Transverse:  $35 \pi \text{ mm mr}$  to  $5 \pi \text{ mm mr}$  in 1.9 seconds

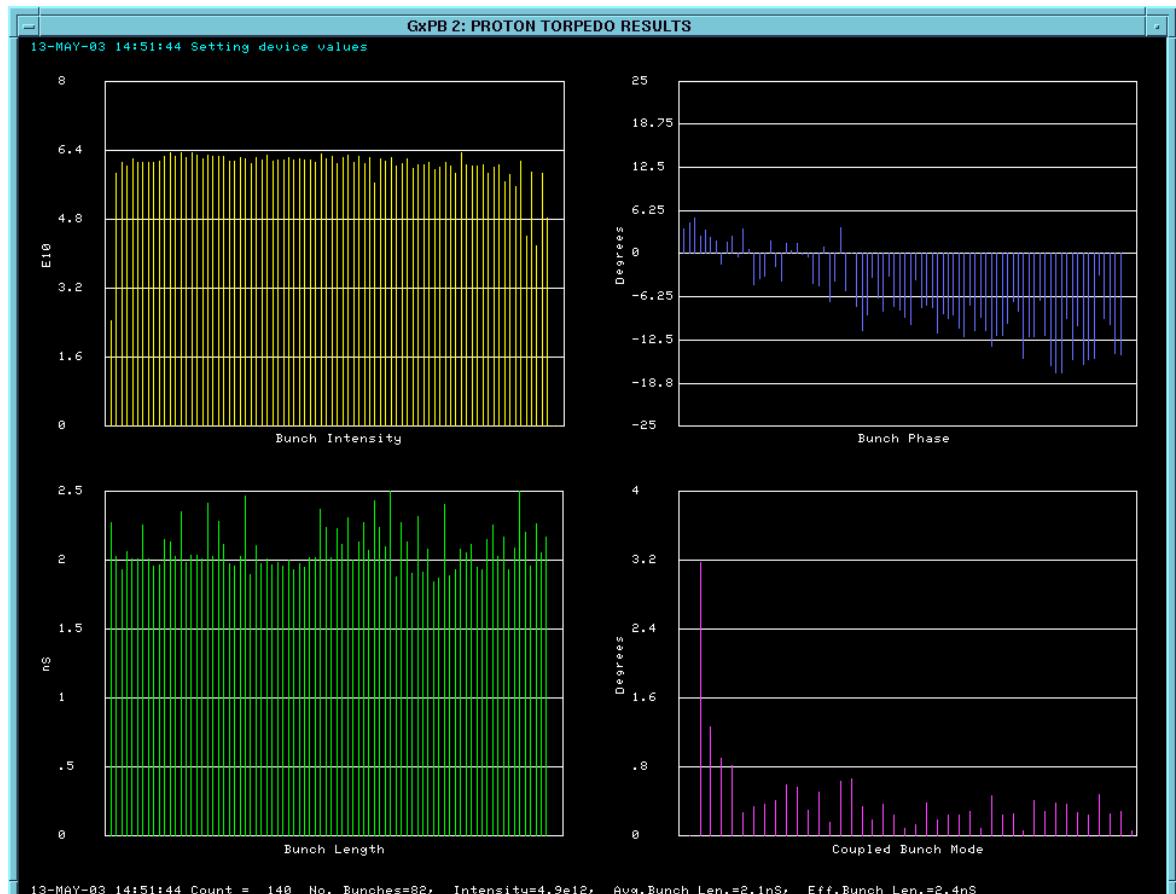
# Bunch Rotation

- Large initial momentum distribution after Bunch Rotation
  - Large time spread from MI  $\sim 2$  nsec
- Energy offset contributes to width and produces high energy tail



# Initial beam parameters

- Measurements made upstream of  $\bar{p}$  target
  - Phase variation through 84 bunches
  - Equivalent to longer average bunch length
  - Beam loading compensation in MI bunch rotation improves phase

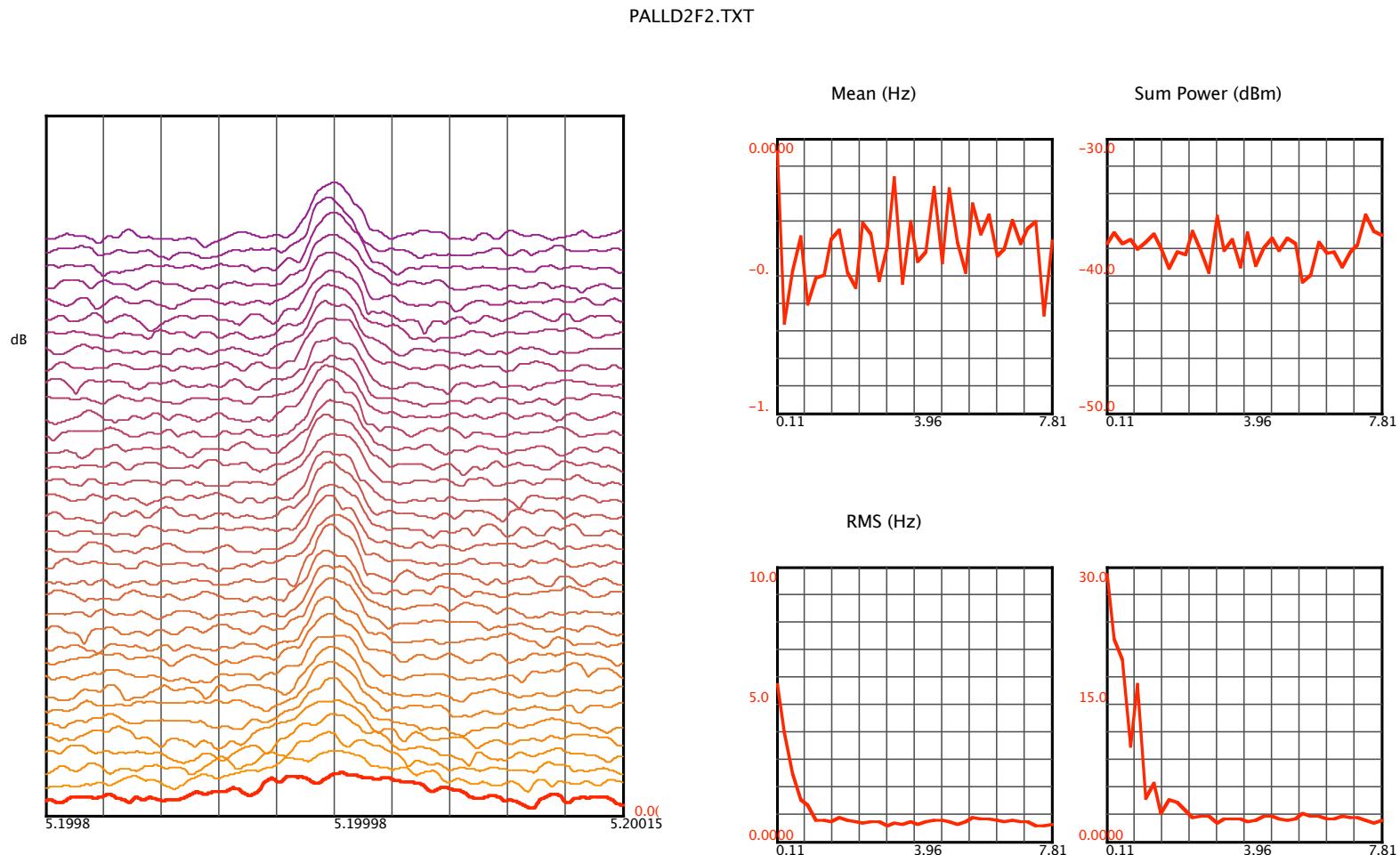


# Measurement technique

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- Measure cooling rate and asymptotic width
- Use 95% width
  - How far stacktail has to move beam to get 97.5% efficiency
- Look at one Schottky band
  - 5.2 GHz
  - 8813th harmonic
  - Uses Debuncher Momentum Band 2
- Spectrum Analyzer:
  - Center 5.2 GHz
  - Span 0 Hz
  - Resolution Bandwidth 1 MHz
  - Use 21.4 MHz IF output
- Vector Signal Analyzer
  - Center 21.4 MHz
  - Span 350 KHz
    - ~100 MeV/c at 8813th harmonic
  - 7 averages
  - Traces every 0.22 seconds
  - Start at end of bunch rotation
  - 5 Pulses

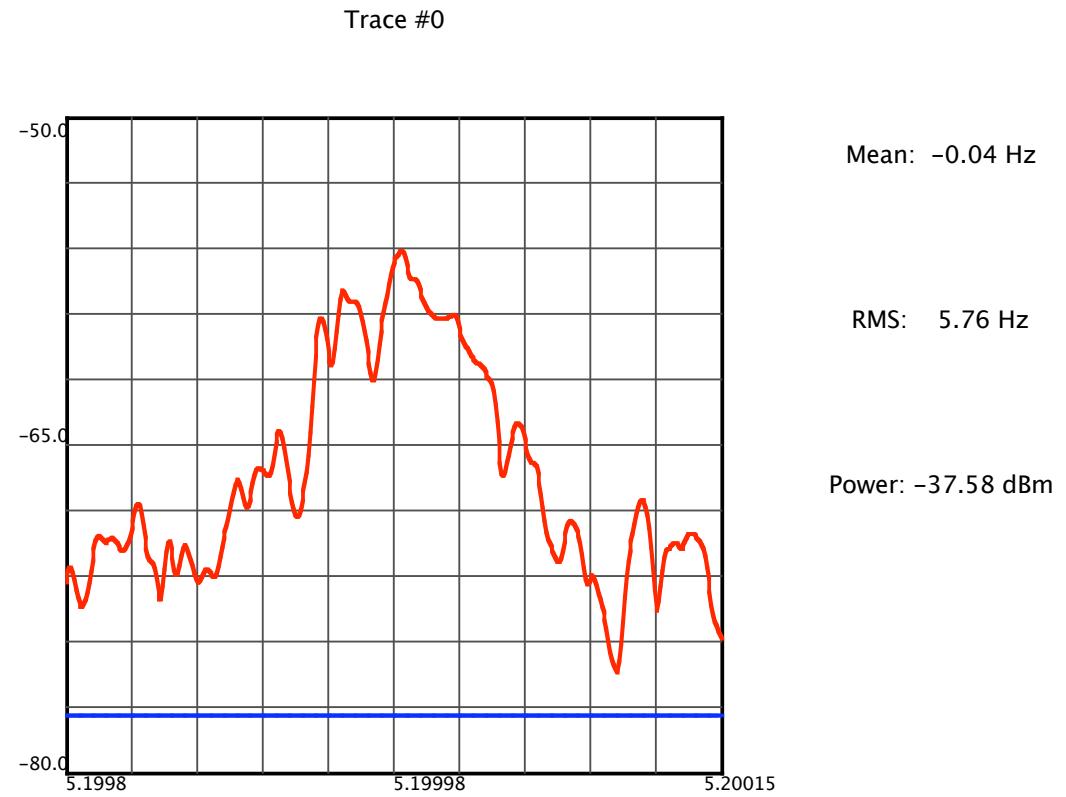
# Sample pulse



## Initial Width

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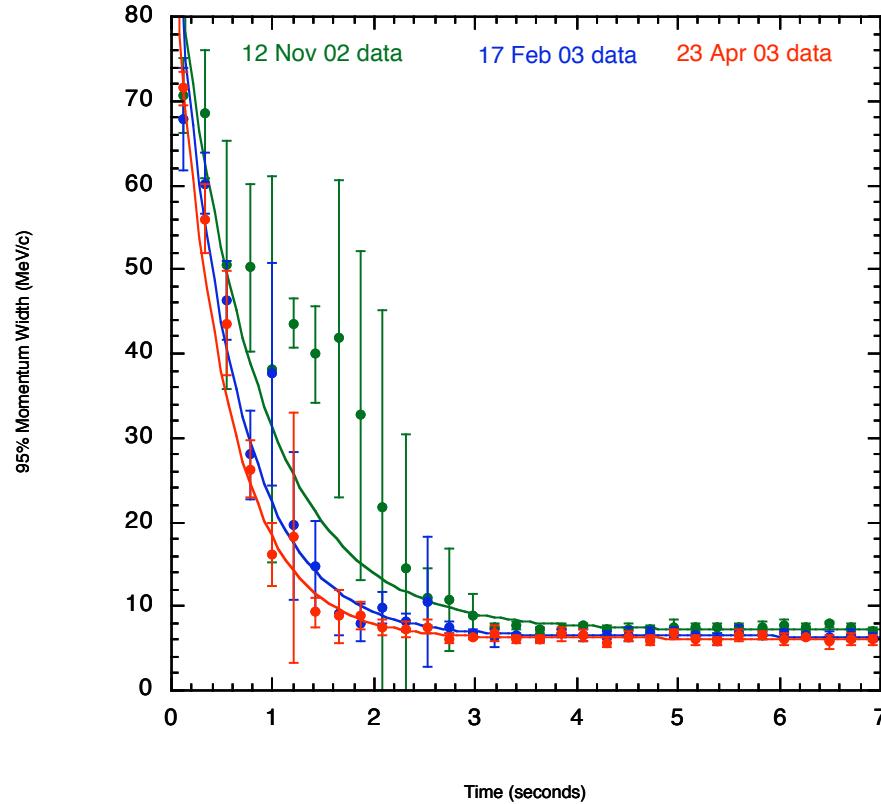
- Initial beam distribution > 100 MeV
- Function of bunch rotation performance
- Beam outside of span move into span
  - Cooling reach ~110 MeV
  - Beam outside of cooling reach heated, N+1 harmonic overlap
  - Can affect 95% width calculations



# Performance

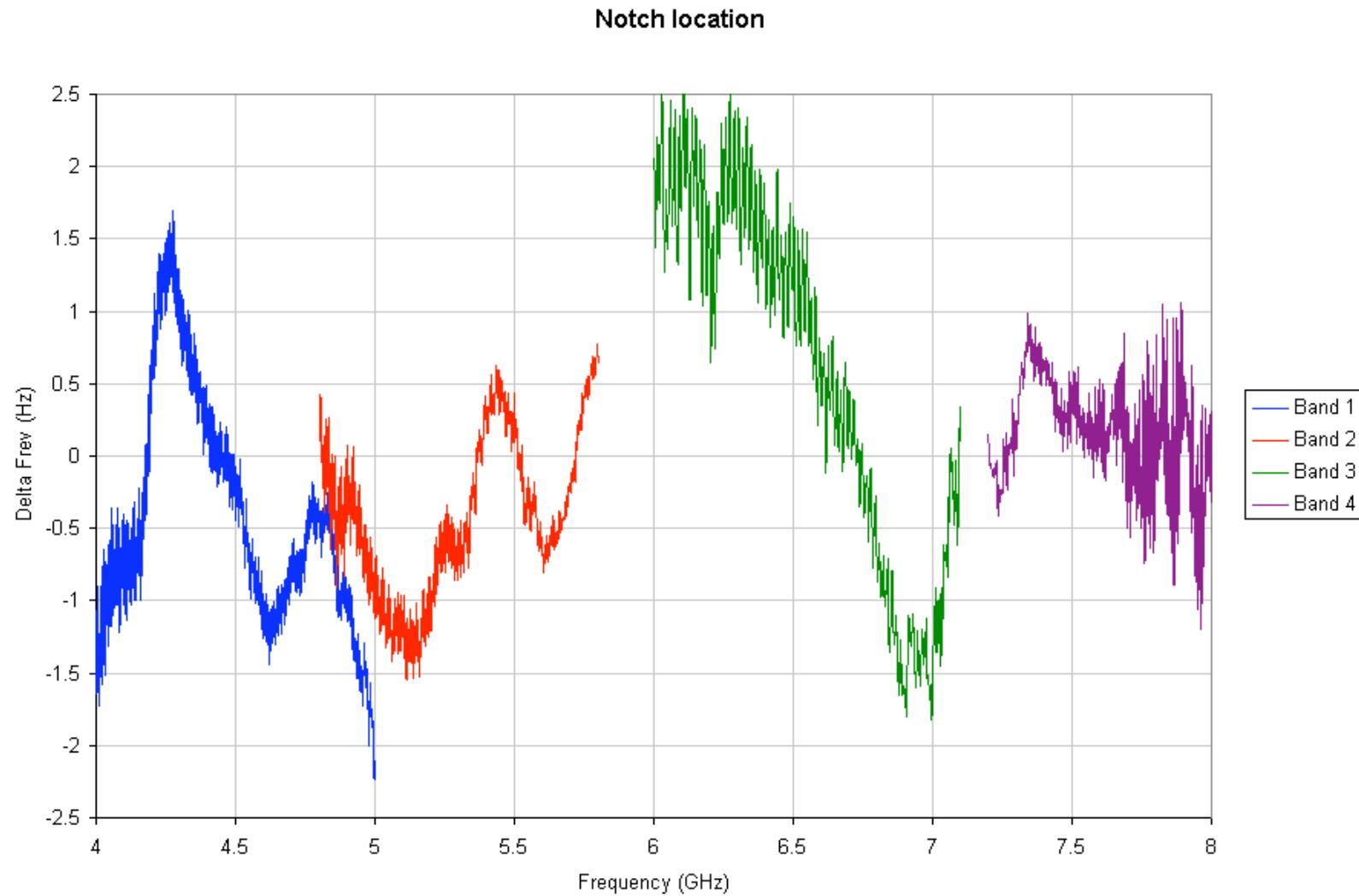
- 5 Pulses: plot average and RMS of the 95% width
- Fit to exponential + constant
- Nov - Apr:
  - Fixed B3 cryo amp
  - B2,B3 & B4 equalizers
  - 0.25 psec resolution in filter trombones (better filter alignment)
- Better equalizers in design stage

$y = W_0^* \exp(-M_0/\tau) + W_{\text{final}}$			$y = W_0^* \exp(-M_0/\tau) + W_{\text{final}}$			$y = W_0^* \exp(-M_0/\tau) + W_{\text{final}}$		
	Value	Error		Value	Error		Value	Error
$W_0$	84.745	4.821	$W_0$	87.122	5.8877	$W_0$	82.25	2.8368
$\tau$	0.79159	0.043388	$\tau$	0.58482	0.043385	$\tau$	0.51829	0.031293
$W_{\text{final}}$	7.1805	0.14236	$W_{\text{final}}$	6.4403	0.10893	$W_{\text{final}}$	6.2024	0.083402
Chisq	80.939	NA	Chisq	14.43	NA	Chisq	14.521	NA
R	0.91364	NA	R	0.98286	NA	R	0.99447	NA



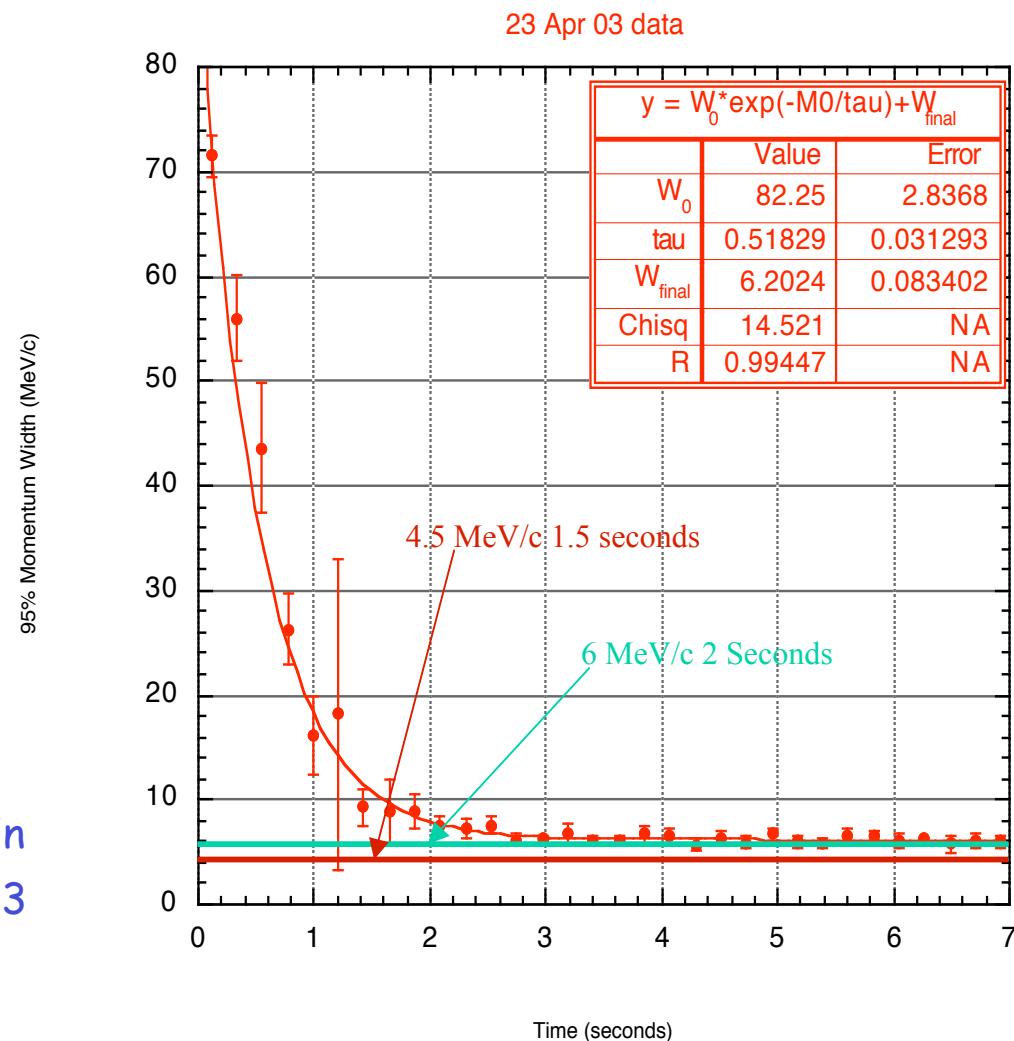
# Notch Locations - 1 Hz ~ 2.5 MeV

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# Desired Performance

- Large initial momentum
- Exponential decay time:
  - 0.5 sec
- @ 2 seconds:
  - $7.9 \pm 0.4 \text{ MeV/c}$
- Goals:
  - Set by Stacktail Performance
  - Need to move beam off deposition orbit before next pulse arrives
  - Rate/Time ~ Voltage gain
  - To move 9 MeV/c, need 3 dB more gain



## Transverse Systems

- Bands 1 & 2 have large common mode signals, which limit gain (as total power is limited)
- Notch filters under design to minimize impact of common mode
- To be installed in FY03
- Working on similar measurements of transverse performance

